

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

In re Application of : Eystein Borgen

Serial No. **10/599109**

Art Unit **3745**

Filed **03/20/2007**

Examiner **Eastman**

**For: A METHOD FOR REDUCTION OF AXIAL POWER VARIATIONS OF A WIND
POWER PLANT**

APPEAL BRIEF

Real Party in Interest

The subject application is owned by the assignee, Sway AS, as recorded at Reel/Frame 119032/0439 in the USPTO assignment database.

Related Appeals and Interferences

None

Status of Claims

On 8 April, 2011 appellant appealed from the final rejection of claims1-12.

Status of Amendments

On 23 June, 2011 an amendment was presented after the filing of the Notice of Appeal correcting a matter of form expressly noted in the final rejection, namely changing a grammatical error in claim 1 (“in order to bringing” is changed to “in order to bring”).

Summary of claimed subject matter

Under the provisions of 37 CFR 41.37(c)(1)(v), the following summary of claimed subject matter is made. The summary is in accordance with the rules since the rule does not require any particular format for this section of the Appeal Brief. Note also the commentary to the rules provides “[a]ppellant may include any other information of record which will aid the Board in considering the subject matter of each independent claim.” 69 FR 49976, Comment 53, third column, August 12, 2004.

Background

This invention relates to a method for adjusting the angle of the rotor blades about their own longitudinal axis in a wind power plant in such manner that the thrust of the rotor on the tower is controlled and kept within desired values without the average output of the wind power plant being affected to any noticeable degree. This has the advantage that the load variations on the rotor blade and tower are reduced, thereby substantially reducing fatigue of these heavily loaded components.

It is desirable to be able to place large commercial horizontally shafted wind turbines on foundations in deep water. This is desirable in order to be able to increase potential regions for wind power exploitation, to obtain access to areas with high average wind velocities and to be able to build wind parks in proximity to oil and gas installations so as to be able to provide these with electricity using wind power.

In deep water, a floating structure will be advantageous in order to limit the size and costs of towers and foundations.

A floating structure of this kind will primarily be affected by two types of forces that will control the motion pattern and stresses on the floating structure. These are waves forces against the floating part of the structure and thrust on the rotor from the wind, referred to herein as the rotor axial force.

For a wind power plant on land or in shallow water that is fixed to the ground or seabed, the dominant forces acting on the structure will usually be, in addition to gravitational forces, the thrust on the rotor from the wind.

It is of course desirable for the wind power plant to generate optimal power output in varying wind conditions. In certain instances the wind velocity is relatively low, in which case it is important to optimize the orientation of the blades of the power plant in order to optimize power output. In other circumstances, however, the wind velocity is higher than necessary. In such circumstances it may be necessary to adjust the blades in order to avoid problems associated with high wind velocity.

For large wind power plants (with outputs of typically 1 MW or more) there are today two main types of regulating mechanisms used to control that the rotor provides a constant output power, equal to the nominal output of the plant, for wind velocities that are higher than necessary in order to achieve full output (nominal output).

One of the methods is stall regulation of the rotor blades. This method turns the blades into the wind so that the angle of attack of the relative wind against the wing profile is increased and the rotor blades reach stall. That is to say that the wind gradually loses its lifting force in that the flows across the rotor blade go from being laminar to being turbulent. Thus, the excess energy is released.

The other regulating method is pitch regulation of the blades whereby the blades are turned in the opposite direction to that in stall regulation so that the wind is released by reducing the angle of attack of the relative wind against the wing profile. Thus, the lifting force of the rotor blade is reduced and less energy is recovered from the wind. This

invention relates to this last regulating method which is called pitch regulation in this application.

Wind velocity that is higher than necessary does not only create a problem related to maintaining optimal power output, however. One such additional problem is that occasionally the wind may gust to such a degree that the blades run the risk of hitting the tower. There exist known methods in the prior art for avoiding this type of problem, such as over-dimensioning the blades, stopping the turbine entirely, or relying on statistical averages. US patent 6,601,918 to Rebsdorf teaches a method for directly measuring dangerous loads on the blades rather than relying on statistical averages such that the turbine may be operated in an aggressive manner except when the wind conditions are actually precarious.

There exists, however, yet another problem associated with varying wind velocity that is not addressed by such prior art techniques. This third problem is that when conventional wind turbines attempt to optimize the power output by altering the pitch of the blades (as described above), the “power-optimizing” pitch-alterations themselves will cause variations in thrust forces acting on the turbine. These variations (both large and small) cause stress that will over time cause fatigue in the entire installation. On the other hand, variation in thrust forces can be *reduced* by making pitch adjustments with that particular goal in mind, but such “stress-reducing” adjustments may come at the expense of power optimization. The present invention is directed to keeping the “stress-causing” type of pitch alterations to a minimum so as to reduce long term fatigue, while at the same time keeping the power output within an acceptable power output range.

Claimed subject matter

Support in the specification for the various features of the claims is provided as follows:

Claim 1 provides for a method for controlling the output of a wind power plant comprising a converter unit (page 5, line 1), the method comprising establishing an output power range for the converter unit (page 5, line 3), measuring the output power of the converter unit, and if the output power of the converter unit is within said range, changing

the pitch angle of the rotor blades in order to minimise variations in the thrust of the rotor blades in the wind direction individually or collectively (page 5, line 5), and if the output power of the converter is outside this range, changing the pitch angle of the rotor blade in order to bringing the power output within the range (page 5, line 7).

Claim 2 provided the additional feature of, wherein the step of minimising variations in the thrust of the rotor blades in the wind direction is done by regulating towards a calculated target value for the thrust of the rotor blades in the wind direction, the target value for the thrust in the wind direction being different for different average wind velocities (page 5, line 8-11).

Claim 3 provides the additional feature of wherein the target value for the thrust of the rotor blades in the wind direction is adjusted in relation to average converter unit output or rotor speed over a given period of time.(page 5, lines 12-14)

Claim 4 provides the additional feature of wherein the target value for the thrust of the rotor blades in the wind direction is predefined and related to given average wind velocities. (page 5, lines 15-17)

Claim 5 provides the additional features of wherein the thrust of the rotor blades in the wind direction is in addition adjusted by changing the rotor rpm by adjusting the generator rotation resistance moment and/or rotor brakes. (page 5, lines 18-20)

Claim 6 provides the additional features of wherein the momentary thrust of the rotor blades in the wind direction can be determined directly or indirectly by means of strain gauges, wind velocity measurements, by measuring geometric deflection of the blades, measuring the generator torque and/or measuring the generator output together with simultaneous measurement of the pitch angles of the blade or blades, and/or by measuring or using the pitch moment of the blades about the rotational axis of the pitch bearing either by mounting the blades leaning backwards in the pitch bearing, or by shaping the blades so that the impact point on the blade is behind the rotational axis of the pitch bearing in relation to the rotational direction of the rotor. (page 5, lines 21-30)

Claim 7 provides the additional features of wherein the pitch angle of the rotor blades is in addition changed with respect to minimising direction errors for the wind power plant. (page 5, lines 31-32)

Claim 8 provides the additional feature of wherein the direction error is corrected if it is outside a given range. (page 5, line 33)

Claim 9 provides the additional feature of wherein the pitch angle of the rotor blades is adjusted differently for different rotational positions. (page 5, lines 34-35)

Claim 10 provides the additional features of wherein the pitch angles of the rotor blades are adjusted individually and/or independent of each other. (page 6, line 1-2)

Claim 11 provides the additional features of wherein the wind field in a plane that is substantially perpendicular to the wind direction is predicted by using directly or indirectly measured values of the wind forces acting on the rotor blade or blades that is/are at the front in relation to the rotational direction of the rotor. (page 6, lines 3-6)

Claim 12 provides the additional feature of wherein the thrust of the rotor blades in the wind direction is used actively to counter motions of the wind power plant tower by regulating the pitch angles of the rotor blades. (page 6, lines 7-9)

Grounds of rejection to be reviewed on appeal

Ground 1

Claims 1, 6-8 and 10-12 are rejected under 35 U.S.C. §102(b) as being anticipated by US 6,619,918 to Rebsdorf.

Ground 2

Claims 2-4 and 9 are rejected under 35 U.S.C. §103(a) as being unpatentable over US 6,619,918 to Rebsdorf.

Argument

Ground 1: Rejections under 35 U.S.C. §102(b)

I. Legal Standard

The initial burden is on the examiner to present a *prima facie* case of anticipation by supplying the factual basis supporting the rejection. *In re Warner*, 379 F2d. 1011, 154 USPQ 173,178 (C.C.P.A. 1967), *cert. denied* 389 U.S. 1057 (1968). The elements of a *prima facie* case of anticipation, as articulated by the Federal Circuit in *W.L. Gore & Associates v. Garlock, Inc.*, 721 F.2d. 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984) requires, “[T]he disclosure in a single prior art document of each element of the claim under consideration”.

II. Analysis

A. separate argument for claim 1

Claim 1 provides the feature of establishing an output power range. Rebsdorf does not teach this feature. This is not surprising as Rebsdorf is not concerned with keeping the power output of the power plant within an acceptable range...rather Rebsdorf is concerned with maintaining a maximum safety limit for wind velocity so that the blades do not hit the tower. The examiner argues that Rebsdorf teaches this feature at col. 1, line 55, col. 2, line 18, col. 2, line 36-58, col. 3, line 1 and col. 4, line 4. The appellant respectfully disagrees with the examiner that the cited passages from Rebsdorf disclose this feature. The cited passages teach that certain parameters are measured, and in particular that mechanical loads on the blades are measured and controlled so that a safety distance is maintained between the blade tips and the tower. Nowhere does Rebsdorf disclose the establishing of an output power range for the power plant however.

Claim 1 provides the additional feature that if the measured output power is within such range, then “stress-reducing” type pitch adjustments are made (which as described above may come at the expense of optimal power output). Rebsdorf contains no teaching of making such a determination or correction. This is not surprising since Rebsdorf is unconcerned with the problem of making trade-off in power output in order to reduce long term fatigue. The examiner seems to suggest that avoiding a dangerous sudden wind gust could be considered “minimizing thrust variations”. But even accepting this generous interpretation, Rebsdorf does not make such adjustments relative to power output, but rather to measured mechanical stresses, and does not make adjustments based on a position within a range, but rather with respect to a maximum wind velocity safety limit.

Claim 1 further provides that if (and only if) the output power is outside the established range, then the (possibly stress-inducing) pitch corrections are made in order to bring the power output back within that range. The appellant respectfully believes that the examiner has misread Rebsdorf, as Rebsdorf contains no such teaching.

B. separate argument for claim 6.

Claim 6 is believed novel at least based on its dependence from claim 1.

C. separate argument for claim 7 and 8.

With respect to claim 7 and 8, Rebsdorf does not contain any teachings related to the direction of the wind power plant, much less that errors in the power plant’s direction may be corrected by altering the pitch angle of the blades, or that a range is employed. Again, Rebsdorf is not concerned with the direction of the power plant or any issue other than the mechanical stresses on the blades themselves.

Ground 2: Rejections under 35 U.S.C. §103(a)

I. Legal Standard

It is the initial burden of the examiner to present a *prima facie* case of unpatentability. Only after that burden is met does the burden of coming forward with evidence shift to the applicant. After evidence or argument is submitted, patentability is determined by a preponderance of the evidence with due consideration to the persuasiveness of the arguments. If the examiner at the initial stage of examination does not produce a *prima facie* case of unpatentability, then without more the applicant is entitled to a patent grant. *In re Oetiker*, 977 F.2d. 1443, 1445 (Fed. Cir. 1992) (citations omitted)

With regard to an obviousness rejection under 35 USC §103, the framework for the objective analysis for determining obviousness under 35 U.S.C. §103 is stated in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). Obviousness is a question of law based on underlying factual inquiries. The factual inquiries enunciated by the Court are as follows:

- (A) Ascertaining the differences between the claimed invention and the prior art; and
- (B) Ascertaining the differences between the claimed invention and the prior art; and
- (C) Resolving the level of ordinary skill in the pertinent art.

The USPTO has issued guidelines to examiners for determining obviousness, to be found at MPEP §2141 et seq. The guidelines provide exemplary rationales that may support a conclusion of obviousness, including:

- (A) Combining prior art elements according to known methods to yield predictable results;
- (B) Simple substitution of one known element for another to obtain predictable results;
- (C) Use of known technique to improve similar devices (methods, or products) in the same way;
- (D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- (E) "Obvious to try" - choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;

The common recurring legal principle as expressed in the examples is that the combination of elements argued by the examiner must produce *predictable* results. Predictability is thus a necessary component of the examiner's articulation of a *prima facie* case of obviousness. See *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976), see also MPEP2143.02 (II).

The rationale to support a rejection under 35 USC §103 may rely on logic and sound scientific principle. *In re Soli*, 317 F.2d 941, 137 USPQ 797 (CCPA 1963). However, when an examiner relies on a scientific theory, evidentiary support for the existence and meaning of that theory must be provided. *In re Grose*, 592 F.2d 1161, 201 USPQ 57 (CCPA 1979).

II. Analysis

In as much as the examiner has not identified any combination of references that disclose all of the features as discussed above, a *prima facie* case of obviousness has not been established.

A. separate argument for claim 2

Claim 2 contains the feature that the minimization of thrust variations is made by regulating towards a calculated thrust value. Rebsdorf does not regulate *towards* a specific thrust value, but rather attempts to *avoid* an unsafe value. In addition, this unsafe value in Rebsdorf is not different for different average wind velocities, but is an absolute value. Rebsdorf attempts to avoid an unsafe situation, and if the wind velocity approaches a value that is unsafe then action is taken. The point at which action must be taken does not change depending upon average wind velocity, the only thing that "changes" is whether or not action must be taken. The present invention, as claimed in claim 2, provides for establishing different target thrust values for different average wind velocities. Rebsdorf contains no such teaching.

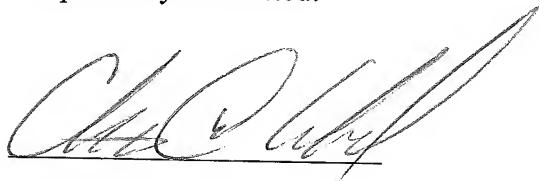
B. separate argument for claims 3,4 and 9

Claim 3, 4 and 9 are believed novel at least based on their dependence from a patentable claim.

Conclusion

For the foregoing reasons, it is respectfully believed that the examiner has not established a *prima facie* case of anticipation under §102 nor of obviousness under §103.

Respectfully submitted.



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CLAIMS APPENDIX

CLAIMS

1. (Previously presented) A method for controlling the output of a wind power plant comprising a converter unit, the method comprising establishing an output power range for the converter unit, measuring the output power of the converter unit, and if the output power of the converter unit is within said range, changing the pitch angle of the rotor blades in order to minimise variations in the thrust of the rotor blades in the wind direction individually or collectively, and if the output power of the converter is outside this range, changing the pitch angle of the rotor blade in order to bring the power output within the range.
2. (Previously presented) A method according to claim 1, wherein the step of minimising variations in the thrust of the rotor blades in the wind direction is done by regulating towards a calculated target value for the thrust of the rotor blades in the wind direction, the target value for the thrust in the wind direction being different for different average wind velocities.
3. (Previously presented) A method according to claim 2, wherein the target value for the thrust of the rotor blades in the wind direction is adjusted in relation to average converter unit output or rotor speed over a given period of time.
4. (Previously presented) A method according to claim 2, wherein the target value for the thrust of the rotor blades in the wind direction is predefined and related to given average wind velocities.
5. (Previously presented) A method according to claim 1, wherein the thrust of the rotor blades in the wind direction is in addition adjusted by changing the rotor rpm by adjusting the generator rotation resistance moment and/or rotor brakes.
6. (Previously presented) A method according to claim 1, wherein the momentary thrust of the rotor blades in the wind direction can be determined directly or indirectly by means of strain gauges, wind velocity measurements, by measuring geometric deflection of the blades, measuring the generator torque and/or measuring the generator output

together with simultaneous measurement of the pitch angles of the blade or blades, and/or by measuring or using the pitch moment of the blades about the rotational axis of the pitch bearing either by mounting the blades leaning backwards in the pitch bearing, or by shaping the blades so that the impact point on the blade is behind the rotational axis of the pitch bearing in relation to the rotational direction of the rotor.

7. (Previously presented) A method according to claim 1, wherein the pitch angle of the rotor blades is in addition changed with respect to minimising direction errors for the wind power plant.
8. (Previously presented) A method according to claim 7, wherein the direction error is corrected if it is outside a given range.
9. (Previously presented) A method according to claim 1, wherein the pitch angle of the rotor blades is adjusted differently for different rotational positions.
10. (Previously presented) A method according to claim 1, wherein the pitch angles of the rotor blades are adjusted individually and/or independent of each other.
11. (Previously presented) A method according to claim 1, wherein the wind field in a plane that is substantially perpendicular to the wind direction is predicted by using directly or indirectly measured values of the wind forces acting on the rotor blade or blades that is/are at the front in relation to the rotational direction of the rotor.
12. (Previously presented) A method according to claim 1, wherein the thrust of the rotor blades in the wind direction is used actively to counter motions of the wind power plant tower by regulating the pitch angles of the rotor blades.

EVIDENCE APPENDIX

- none -

RELATED PROCEEDINGS APPENDIX

- none -